Fertilization Recommendation for Rice Field Based on Nutrient Status of N, P, K, and pH in Central Bengkulu Regency

Tri Wahyuni and Bunaiyah Honorita

Assessment Institute for Agricultural Technology (AIAT) Bengkulu, Indonesia
Jl. Irian Km 6,5 Bengkulu
E-mail: fathin.unee@gmail.com

ABSTRACT

The evaluation of status and dynamics of nutrients in the soil can be used as the balanced fertilization recommendations in compliance with the needs of plant growth. In order to be more effective and efficient, the balanced fertilization is not necessary to give all of macro/micro elements that available in forms of fertilizer, but only gives elements that in sufficient to the grow of plant. Based on this consideration, the assessment of paddy fertilization by using Paddy Soil Test Kit was conducted in Central Bengkulu Regency. The assessment was conducted for fand hoour months, hoped it would produced the balanced fertilization recommendation based on Paddy Soil Test Kit. The assessment method was done through semi-qualitative by colorimetric method (coloration) to measure N, P, K nutrients and soil acidity (pH) in the form of available. Soil nutrient analysis result in Central Bengkulu Regency showed that itwas dominated by moderate-K element (88.89%), then high-N element (77.78%) and low-P element (50%), with pH was in slightly acid conditions. Based on this condition, the fertilization recommendation wereN 200-250 kg urea/ha for New Prime Variety (NPV) paddy and 250-300 kg urea/ha for hybrid paddy, P 100-125 kg SP-36 for NPV paddy and120-150 kg sp-36/ha for hybrid paddy. Fertilization for K was strongly suggested by returning rice straw to field, whereas field management was using conventional drainage system.

Key words: fertilization, rice field, paddy soil test kit, Central Bengkulu

INTRODUCTION

Good and fertile soil is soil that able to provide nutrient elements in sufficient and balanced to fulfill the needs of plant growth. One common way that usually done is analyzing the productivity value of land based on the concentration of nutrients that contained in the soil (Yamani, 2010). Therefore, the effort to increase land productivity can be done by enhanced soil nutrient status. Related to the management and using of land, not all of rice fieldneeds N, P, and Kfertilizer in the same amount and even some of them does not need fertilizer at all (Nurhayati *et al*., 2012).

The research resulted of Indonesian Agency for Agricultural Research and Development (IAARD) showed that the level of fertility of rice fields in Indonesia has declined. To overcome this problem, fertilization becomes one of solutions so that land productivity can be maintained optimally. In these conditionit is natural that the fertilizer demand for rice field increased from year to year. However, another problem arises that related to the increase of the amount of production cost so that indirectly it would reduce farmers' income. Charging for this cost will lead the ability of farmers in increase fertilizer dose is also lower. As a result the marginalization of land will be continue to occur, which in turn will lead the land tends to degraded both physically and chemically (Palembang *et al*., 2013).

One of agricultural production means thatis important in improving crop production is fertilization. Applying a balanced fertilization is one of the ways that can be used to support government programs in order to improve national food security. In addition, applying a balanced fertilization can improve fertilization efficiency, crop production, save fertilizer and foreign exchange, and in the long term can reduce environmental pollution (Dahlan *et al*., 2012). On the land with a condition that has reached optimum levels or high status, fertilizer application is used to replace nutrients transported during harvest. Nutrient source can be either a single fertilizer, compound fertilizer, or combination both of them (Suwono *et al*., 2012).

Balanced fertilization recommendation should be based on the value assessment of status and dynamics of nutrients in the soil and crop needs. Balanced fertilization have not to provide all of

macro/micro elements that needed, but provide the elements that the amounts were not available to plant. The addition of nutrient that were enough available actually causes the problem of environmental pollution (soil and water), especially if the soil nutrient status is very high. As an example fertilization application of P continuously on paddy intensification causes saturation of P and nutrient imbalance in the soil. Fertilization of P is no longer to provide a real increase of crop. Fertilization efficiency becomes low, and the possibility of other nutrients such as Zinc (Zn) becomes unavailable (Kasno and Setyorini. 2012).

According to Al-Jabri (2007), fertilization recommendation based on soil test for food crops, vegetables, and plantations have not been established, when the excessive application of fertilizer can give negative impacts such as soil degradation and environmental pollution.

Fertilization recommendations are very needed because mostly farmers in Central Bengkulu Regency apply fertilizer based on custom rather than the needs of the plant. The amount of fertilizer that used could be excessive so that increasing the cost or the amount of fertilizer that used is less than the needs of the plants that cause nutrient deficiencies so that production is not maximized. Therefore, fertilization recommendation based on nutrient status is very needed by the farmers in Central Bengkulu Regency.

There are several ways that can be done to find out the status of nutrients in the soil. One way that is practical, efficient, and can be done in the field by both farmers and extensionist is using Paddy Soil Test Kit. It is one of the tools that can be used to determine the nutrient status of N, P, K and pH in the soil and fertilization recommendation accordance with the needs of the plant (Departemen Pertanian. 2007). This activity aims to determine the nutrient status and fertilization recommendation for rice field based on analysis using Paddy Soil Test Kit in Central Bengkulu Regency.

MATERIALS AND METHODS

The research to obtain fertilization recommendationtook place from March until June 2012 in Central Bengkulu Regency. Soil sampling was conducted in 8 sub-districts, spread over 18 villages. Designation of sampling location is based on the consideration that the area is a center of rice cultivation in Central BengkuluRegency. Tools and materials that used for this activity are drill ground, hoe/shovel, plastic buckets, plastic bags, markers, pens, pocket books, Paddy Soil Test Kit (color chart, test tubes, stainless spoon, glass stirrer, test tube rack, tissue paper dryer, 2 ml syringe and test tube cleaning brush). Whole soil samples were collected and analyzed using Paddy Soil Test Kit.

Soil sampling is done by using drill or hoe to a depth of 20 cm from the ground, on a homogeneous stretch of land. Every single composite soil sample is a mixture of 5-8 single soil samples. Then to determine the nutrient status of N, P, K and pH of each soil sample was tested using Paddy Soil Test Kit. This toolprocedure is to measure by semi qualitative of N, P, K and pH of the soil that contained in available form, by colorimetric method (coloration). While the result of measurement of the level of N, P and K soil was grouped into three categories: Low (L), Medium (M), and High (H).

RESULTS AND DISCUSSION

Central Bengkulu Regency is one of the areas in Bengkulu Province, which is largely a plateau with altitude of 0-150 m above sea level, while the eastern part is hilly topography with an average altitude of 541 m above sea level. In general, its soil type are dominated bylatosolsand andosol (30.46%) followed by regosol (30.10%). The rest is red-yellow podzolic soil (13.14%), brown podzolic and red-yellow podzolic soil (7.09%), alluvial (7.06%), andosol and regosol (6.07%), latosols (5.66%), organosol (0.42%) (BPS Central Bengkulu, 2012).

Based on the review of science soil and its fertility (Henry, 1991), the character of latosols soil is soil type that has been weathering intensivelyand soil development further. Usually this dominant of soil characteristic is low clay and less active, low cation exchange capacity, low mineral content, low levels of soluble material, and high aggregate stability. Then andosol is neutral to acidic soil, high in organic matter and clay. In contrast to latosols and andosol association which is a mix of latosols and andosol that are distinguishable or separated.This soil type is dominant in Central Bengkulu Regency.

Based on Paddy Soil Test Kit analysis result to 18 samples of soil in Central Bengkulu Regency, 14 samples had a high N status (77.78%), 9 samples were low P status (50%), 16 samples were

medium K status (88.89%) and pH was in slightly acid conditions. The analysis results of nutrient element of N, P, and K are presented in Table 1.

Table 1. The analysis results of nutrient element of N, P, and K

No.	Village	Nutrient Status		
		Urea	SP-36	KCl
1.	Sido Rejo	High	High	Medium
2.	Sri Kuncoro	High	Medium	Medium
3.	Sido Dadi	Low	Low	Low
4.	Karang High	Low	Medium	Medium
5.	Durian Demang	High	Low	Medium
6.	Dusun Baru	High	Low	Medium
7.	Taba Terunjam	High	Low	Medium
8.	Tanjung Terdana	High	Low	Medium
9.	Taba Baru	High	Medium	Medium
10.	Taba Penanjung	High	High	Medium
11.	Sukarami	Low	High	Low
12.	Taba Teret	High	Low	Medium
13.	Rindu Hati	Low	Low	Medium
14.	Surau	High	Low	Medium
15.	Keroya	High	Medium	Medium
16.	Punjung	High	High	Medium
17.	Taba Terunjam	High	High	Medium
18.	Kelindang	High	Low	Medium

Fertilization Recommendation of N

Based on the analysis, the nutrients elements of N are generally divided into two categories: high N and low N. Therefore, its fertilization recommendations should be in line with its status high N and low N. High N fertilization recommendations for New Prime Variety (NPV) for 5 tons target production of dry milled grainper hectare is in the amount 200 kg/ha, for 6 tons target of dry milled grain/ha is 250 kg/ha. Similarly, for 7 tons target of dry milled grain/haof hybrid rice is 250 kg/ha and for 8 tonstargetof dry milled grain/ha is 300 kg/ha. In contrast to the low N fertilization recommendation for NPV rice for 5 tons target production of dry milled grain per hectare is 300 kg/ha, for 6 tons target is 350 kg/ha, for 7 tons target of dry milled grain/ha of hybrid rice is 350 kg/ha and for 8 tons target dry milled grain/ha is 400 kg/ha (Figure 1).

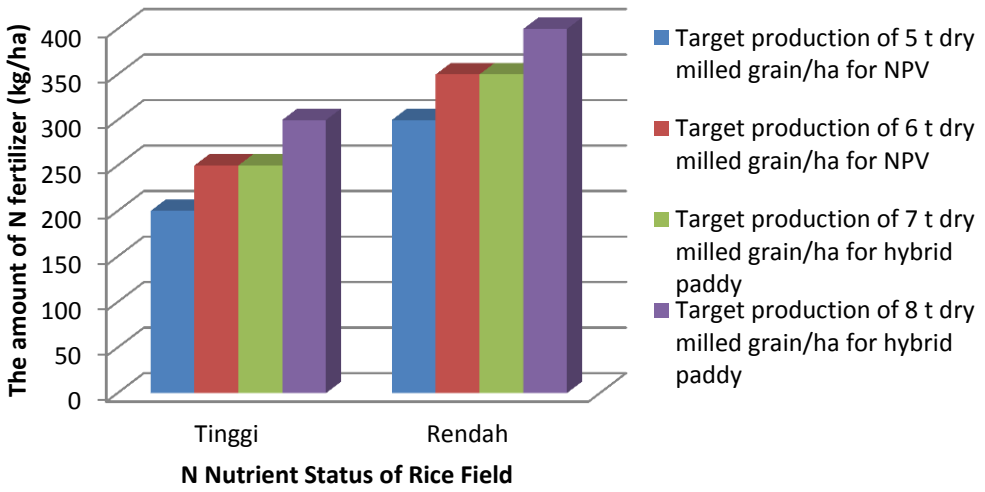

Figure 1. N fertilization recommendation

Since the soil of rice field in Central Bengkulu Regency is generally sandy soil (clay <20%) so that urea fertilization application is recommended to be applied3 times (1/3 of the part isto 1-2 weeks after planting, 1/3 of the part is to 3-5 weeks after planting, and 1/3 of the part is to 6-7 weeks after planting). These recommendations do not apply if N fertilizer that used is in the form of urea tablets/briquettes/granules which is the fact the available nutrients are very slowly unraveled. Therefore its application recommendation is enough once for one growing season.

As the common practice by farming communities in Central Bengkulu Regency, the source of N fertilizer that is widely used by farmers is urea and the way of application is done by spreading it on the soil surface. This way is less efficient because it causes loss of N through evaporation (volatilization) as big as 60% from fertilizer applied. To overcome it, the way of fertilization that suggested is by immersing and then trampled. These suggestion and recommendation are very necessary so that farmers can obtain the maximum results (Setyorini *et al*.,. 2012).

Due to the excessive fertilization application will not increase productivity but instead reduce crop yields. As it is known that nitrogen as the main macro nutrient is very needed in the process of plant growth and needed in large amount absorbed by plants, either in the form of ammonium (NH_4^+) or in the form of nitrate (NO_3^+). For the production of crop, N is including of fourthfrom 16 essential elements that needed by plants.

Fertilization Recommendation of P

Based on the analysis of P nutrient it is generally divided into three categories: high P, medium P, and low P. Therefore, its fertilization recommendations should be in line with its status of high P, medium P, and low P. High P fertilization recommendations for New Prime Variety (NPV) for 5 tons target production of dry milled grainper hectare is in the amount 50 kg/ha, for 6 tonstarget dry milled grain/ha is 75 kg/ha. Similarly, for 7 tons target of dry milled grain/ha of hybrid rice is 60 kg/ha and for 8 tons target of dry milled grain/ha is 90 kg/ha.

As for the medium P fertilization recommendation for NPV for 5 tons target productiondry milled grain per hectare is 75 kg/ha, for 6 tons target is 100 kg/ha, for 7 tons target dry milled grain/ha of hybrid rice is90 kg/ha and for 8 tonstarget of dry milled grain/hais120 kg/ha. In contrast to the low P fertilization recommendation for NPV for 5 tons target production of dry milled grain per hectare is 100 kg/ha, for 6 tons target is 125 kg/ha, for 7 tons target of dry milled grain/ha of hybrid rice is120 kg/ha and for 8 tons target of dry milled grain/ha is 150 kg/ha (Figure 2).

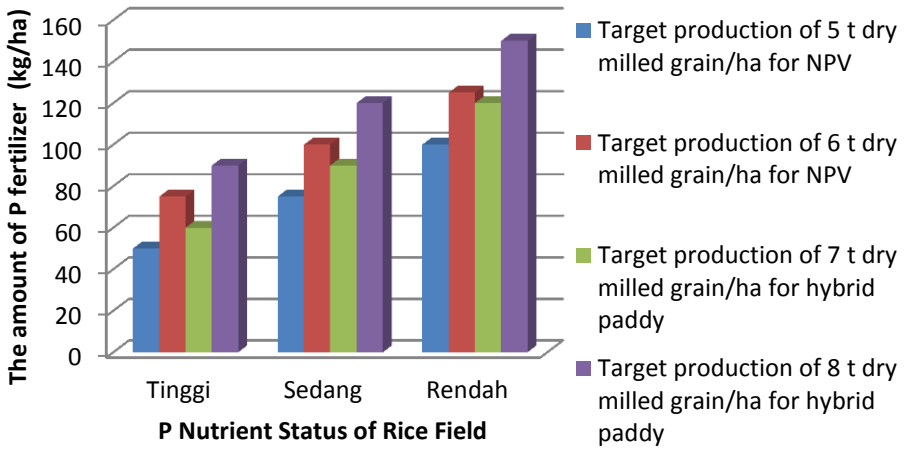

Figure 2. P fertilization recommendation

The fertilization recommendations as shown in figure 2 showed that each region requires phosphorus in different amount in accordance with its nutrient status. P fertilization application is generally given once at the time of planting. The fertilizer of P (phosphorus) plays an important role in protein synthesis, the formation of flowers, fruits, and seeds and accelerating the ripening. The lack of

P can cause stunted plant growth, little puppies, late ripening, and low crop production. As a result of P fertilizer in large quantities and sustainable in intensification of rice field for many years, there has been accumulation of P in the soil. This accumulated of soil P can be reused by the next crop if soil reaction reached optimal conditions for the release of P (Setyorini *et al*., 2012).

Phosphorus together with nitrogen and potassium, are classified as the major elements although it is absorbed in smaller amount of the two elements. Plants usually absorb P in the form of H_2PO^{4-} and a small portion in the form of secondary HPO_4^{2-}. The absorption of both ions by plants was affected by soil pH around the roots. At low soil pH, the absorption in the form of H_2PO^{4-}would be increased, phosphates are most easily absorbed by the plants at approximately neutral pH (pH 6-7) (Rosmarkam and Yuwono, 2002).

Fertilization Recommendation of K

Based on the analysis of K nutrient is generally divided into two categories namelymedium K and low K. Therefore, its fertilization recommendations should be in line with its status medium K and low K that followed with or without the replacement of straw to the field. Medium K fertilization recommendations without the replacement of straw to New Prime Variety (NPV) for 5 tons target production of dry milled grainper hectare is in the amount 50 kg/ha, for 6 tons target of dry milled grain/ha is 75 kg/ha, for 7 tons target of dry milled grain/ha of hybrid rice is 60 kg/ha and for 8 tons target of dry milled grain/ha is 90 kg/ha. As for the low K fertilization recommendation withoutthe replacement of straw for NPV for 5 tonstarget production of dry milled grain per hectare is 100 kg/ha, for 6 tons target is 125 kg/ha, for 7 tons target of dry milled grain/ha of hybrid rice is120 kg/ha and for 8 tons target of dry milled grain/hais150 kg/ha.

In contrast to the medium P fertilization recommendation withthe replacement of straw for NPV for 5 and 6 tons target production already do not require the addition of K fertilizer, for 7 tons target of dry milled grain/ha of hybrid rice is10 kg/ha and for 8 tons target of dry milled grain/hais 15 kg/ha. As for the low K fertilization recommendation with the replacement of straw for NPV for 5 tons target production of dry milled grain per hectare is 50 kg/ha, for 6 tons target is 75 kg/ha, for 7 tons target ofdry milled grain/ha of hybrid rice is 60 kg/ha and for 8 tons target of dry milled grain/ha is 90 kg/ha (Figure 3).

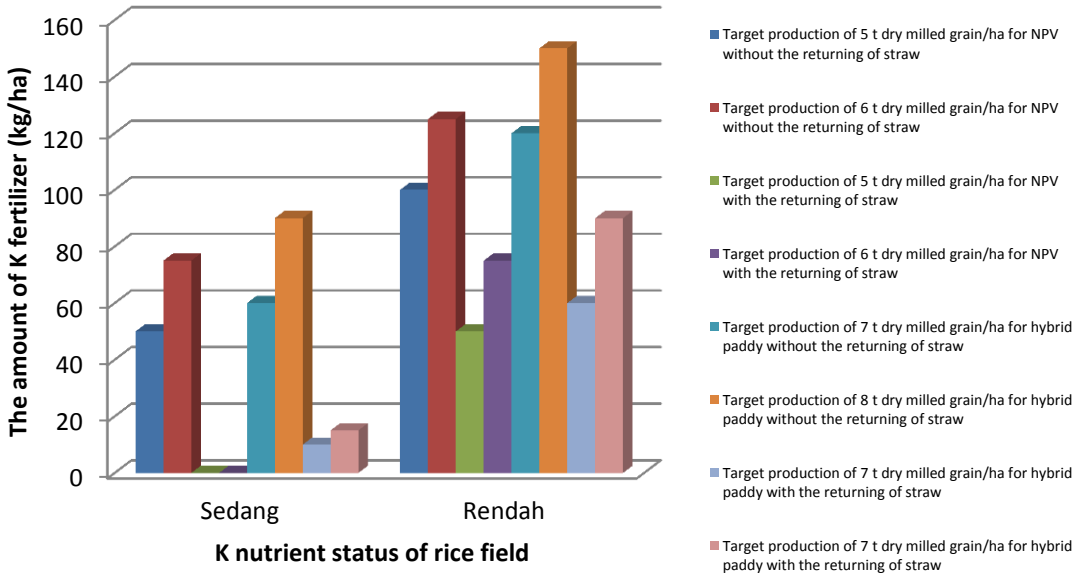

Figure 3. K fertilization recommendation

The K (potassium) fertilizer in plant has the function to control physiological and cell metabolism processes, and increase resistance to disease. K nutrient deficiencies cause stunted plants, weak (not upright), the transport of nutrients, respiratory, and impaired photosynthesis, which finally

reduces the production. K fertilization application in rice field is done 2 times (½ of its part is for 12 weeks after planting, and ½ of its part is for 3-5 weeks after planting). In rice plants, the majority of K nutrients from fertilizer can be replaced by rice straw that is returned as organic fertilizer. K content in straw is generally about 1% so that in 5 tons of straw there is 50 kg of K that equal to the fertilization of 50 kg KCl/ha.

Returning the straw in the form of fresh or composted to rice fieldcontains not only element of K, but also contains other nutrients such as N, P, Ca, Mg, micro-nutrients, hormones regulating growth and organic acids which are very useful for plants. Besides the addition of straw and other organic materials can improve the physical and biological properties of the soil which can indirectly improve and streamline the availability of nutrients to plants (Setyorini *et al.*, 2012).

Plants need potassium in large numbers. As the third macro nutrients that are required after nitrogen and phosphorus, sometimes crop needed for potassium more than crop needed for nitrogen. Total potassium level in the soil is generally high, and it is estimated to reach 2.6% from the total weight of the soil, but available potassium in the soil is low enough. Fertilization nutrients of nitrogen and phosphorus in large quantities also increase the uptake of potassium from the soil, leaching and erosion causethe bigger potassium loss (Damanik *et al.*, 2010).

Rice Land Management Recommendations Based on pH

Based on the analysis, the pH of the rice fields in Central Bengkulu Regency is in the category of slightly acid (pH 5-6). Management recommendation is by conventional drainage systems and fertilizer application in the form of urea. Low or high soil pH is generally only found in new cultivate of rice field or rice field with poor drainage. At the old rice fields (after> 5 years cultivated) rice field pH is near neutral (pH between 5.5 - 6.5).

The important soil reactionsareacid, neutral or alkaline. It is based on the number of H^+ and OH^- ions in the soil solution. Soil reaction which exhibits the nature of acidity or alkalinity of the soil is assessed based on the concentration of H^+ and expressed as pH values. When in the soil is found more H^+ ions than OH^- ions, it is called acid (pH <7). When H^+ ionsare same asOH^- ions is called neutral (pH = 7), and when more OH^- ions than H^+ ions is called alkaline (pH> 7). Soil pH measurement can provide information about the need for lime, soil responses to fertilization, chemical processes that may take place in the process of soil formation, and others (Foth and Adisoemarto, 1994).

CONCLUSION

Rice field nutrient status in Central Bengkulu Regencyis generally dominated by high N elements, then medium Kelements (88.89%), low P element (50%), with the overall pH is in slightly acid condition. Based on this condition, the fertilization recommendation is adapted to nutrient status and the varieties that used by farmers in each village. Fertilization of K is strongly suggested by returning the rice straw to the fields, while the rice field management isrecommended with conventional drainage systems.

ACKNOWLEDGEMENT

We would like to thank to The Agriculture Department of Central Bengkulu Regency for all cooperation and assistance.

REFERENCES

Al-Jabri, M. 2007. Perkembangan Uji Tanah dan Strategi Program Uji Tanah Masa Depan di Indonesia. Jurnal Litbang Pertanian, 26 (2): 54-66.

BPS Bengkulu Tengah. 2012. Kabupaten Bengkulu Tengah Dalam Angka 2012. Badan Pusat Statistik Kabupaten Bengkulu Tengah. Bengkulu Tengah.

Dahlan, D., Y. Musa, dan M.I. Ardah. 2012. Pertumbuhan dan Produksi Dua Varietas Padi Sawah Pada Berbagai Perlakuan Rekomendasi Pemupukan. J. Agrivigor 11(2): 262-274, Mei – Agustus 2012; ISSN 1412-2286.

Damanik, M.M., B. E Hasibuan, Fauzi, Sarifuddin dan H. Hanum. 2010. Kesuburan Tanah dan Pemupukan. Universitas Sumatera Utara Press. Medan.

Departemen Pertanian. 2007. Pengelolaan Tanaman Terpadu (PTT) Padi Sawah; Pedoman Bagi Penyuluh Pertanian. Departemen Pertanian. Jakarta.

Foth, H. D. 1991. Dasar-dasar Ilmu Tanah. Gadjah Mada University Press. Yogyakarta.

Foth, H.D dan Adisoemarto S. 1994. Dasar-dasar Ilmu Tanah. Erlangga. Jakarta.

Palembang, J.N., Jamilah, Sarifuddin. 2013. Kajian Sifat Kimia Tanah Sawah DenganPola Pertanaman Padi Semangka Di Desa Air Hitam Kecamatan Lima Puluh Kabupaten Batubara. Jurnal Online Agroekoteknologi Vol.1, No.4, September 2013. ISSN No. 2337- 6597.

Kasno A. Dan D.Setyorini. 2008. Neraca Hara N, P, dan K pada Tanah Inceptisols dengan Pupuk Majemuk untuk Tanaman Padi. Jurnal Penelitian Pertanian Tanaman Pangan, Vol. 27 NO. 3 2008

Nurhayati, R.F. Zona, dan A. Jamil. 2012. Status Hara dan Rekomendasi Pupuk Padi Sawah di Kabupaten Siak. Prosiding Seminar Nasional: Teknologi Pemupukan dan Pemulihan Lahan Terdegradasi. BBP2SLP. Bogor.

Rosmarkam dan N. W. Yuwono. 2002. Ilmu Kesuburan Tanah. Kanisius.Yogyakarta.

Setyorini, D., L. R. Widowati dan A. Kasno. 2012. Petunjuk Penggunaan Perangkat Uji Tanah Sawah (Paddy soil test kit). BBSDLP. Bogor.

Suwono, M. Soleh, Mardjuki, E. Purnomo, M. Saeri, L. Sunaryo, F. Kasijadi dan Suyamto. Penyusunan Rekomendasi Pemupukan P dan K Padi Sawah Berdasarkan Status Hara P dan K di Pasuruan dan Lumajang. Prosiding Seminar dan Ekspose Teknologi Hasil Pengkajian BPTP Jawa Timur. ISBN 979-3450-04-5.

Yamani, A. 2010. Analisis Kadar Hara Makro dalam Tanah pada Tanaman Agroforestri di Desa Tambun Raya Kalimantan Tengah. Jurnal Hutan Tropis Volume 11 No. 30: 37-46.